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Characterizing Injury among Battlefield Airmen



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1.0 SUMMARY

U.S. Air Force Battlefield Airmen (BA) are an elite group of warfighters whose duties require members to remain in peak physical condition to maintain mission readiness. The substantial financial, material, and personnel resources required to train and maintain this elite group may be burdened by attrition and shortened careers due to illness and injury. Critical in aiding injury prevention and maintaining health for mission performance, injury characterization provides valuable data for BA training and treatment.

Secondary data analyses were performed on medical data to calculate injury frequencies by body region. Descriptive analyses were conducted on the four main BA career fields, BA as a whole, and Security Forces as a control group. From 2006 to 2012, injuries to the lower extremities and vertebral column accounted for 75% of all injuries in BA. BA and Security Forces had similar injury rates. The largest subcategory of injury occurred in the “lumbar vertebral column.” The most expensive injury was to the vertebral column, with a \$615 median cost per incident injury.

2.0 INTRODUCTION

U.S. Air Force (USAF) Battlefield Airmen (BA) are an elite group of warfighters whose duties require a substantial degree of physical and mental strength, agility, stamina, and discipline. These Special Operations personnel require a great deal of resources to train and maintain operational readiness and manpower levels. These BA include Combat Controllers (CCT), Pararescuemen (PJ), Tactical Air Control Party (TACP) members, and Special Operations Weather Technicians (SOWT).

All four of these groups contain highly trained and elite personnel with specialized skills that make them valuable resources to missions. The CCTs work as members of Air Force Special Tactics Teams as well as members of the Army Special Forces, Navy SEAL, and Joint Special Operations teams. CCTs are certified air traffic controllers and Joint Terminal Attack Controllers in dangerous environments. CCTs have a demanding range of duties such as being deployed by sea, air, and land to take over an airstrip, set up equipment, and direct airplanes and helicopters when there is not a tower or advanced communications system available. They can also control parachute drops and control airstrikes. The PJs conduct rescue operations and are personnel recovery specialists. They also have medical capabilities and are among the most highly trained emergency trauma specialists in the U.S. military. They maintain their medical technician-paramedic qualification throughout their careers and are able to perform life-saving missions in the most hostile and remote environments. Battlefield and Special Operations weathermen have tactical training to operate in aggressive or secluded territories. They collect weather information, help with mission planning, and generate mission-tailored forecasts. They also conduct special reconnaissance and maintain weather data reporting networks. TACP personnel advise ground maneuver commanders and provide attack control to aircrew. They operate behind enemy lines and coordinate with Theater Air Ground System [1]. During their missions, BA are subject to increased risk for injuries due to the physically and emotionally demanding nature of their duties. Some of these duties include carrying a large amount of gear to unstable and high elevations [2]. To train this group of elite warfighters, immense resources are needed, and these valuable resources can be burdened due to the high attrition rate from illness and injury.

The majority of the Special Operations forces spend their time with Army and Navy personnel, with some receiving similar training as Navy SEALs or Green Berets. To become a PJ or CCT, candidates begin by attending a 10-week session at the Pararescue/Combat Control Pre-Conditioning School at Lackland Air Force Base in Texas. Then they spend 4 weeks at Special Forces Combat Diver School in Florida. After this, they go to a 3-week session at the U.S. Army Basic Airborne School in Georgia. Afterward, they spend 4 weeks learning parachuting techniques at the Army's Freefall School in North Carolina, then 17 days at the Air Force's Combat Survival School in Washington. After all of this training, the candidates then attend a 1-day course in underwater egress training. From this, the PJ trainees move on to 32 weeks of pararescue training at Kirtland Air Force Base. The CCT trainees go to the Air Traffic Control School in Mississippi for 16 weeks and then to the Combat Control School in North Carolina for 13 weeks [3]. BA training is one of the most rigorous in the U.S. military, with more than 70% attrition rate [3]. It is important to determine where and how these injuries are occurring to prevent injury and increase the life of a BA. While there have been studies conducted on illness and injury in the Air Force, there is a lack of knowledge pertaining to the BA. Although medical diagnoses exist within the electronic health record, these data have not been summarized since 2005 [2]. Summarizing these data may provide insight into degradations in performance and cost of injury. One study found the most important medical factors leading to lost training days among BA trainees were upper respiratory infections and musculoskeletal injuries, but they were unable to determine if the medical issues were indicative of the nature of the training or due to accidental injury [4].

One study compared injuries, limited-duty days, and injury risk factors in infantry, artillery, construction engineers, and Special Forces (SF) soldiers and found that SF soldiers (>27 years old) were at a high risk for musculoskeletal injuries. The SF soldiers also had a higher percentage of traumatic injuries than overuse injuries. This may be due to exposure to activities such as parachuting, running, and climbing with packs. These activities can cause a higher risk of trauma. The SF soldiers had the highest average number of limited-duty days compared to the other groups [5]. One study that investigated clinical diagnoses in the 5th Special Forces Group at Fort Campbell, KY, found that 40% of all clinical diagnoses during fiscal year 2007 were for musculoskeletal conditions. They also found that spine and upper extremity-related diagnoses accounted for 50% of the musculoskeletal diagnoses. This was different from previous studies conducted on the Army populations, which found that lower extremity diagnoses accounted for the majority of the musculoskeletal burden. This may be due to the slightly older average age of the SF soldiers compared to other units as well as the effect of repetitive microtrauma from airborne operations, wearing heavy body armor, carrying heavy loads, and combative training. Of all of the units that were studied, SF had the highest incidence of injury rate, which was 12.1 per 100 soldier-months [6].

Injuries are common in military parachuting and pose a risk to Special Operations personnel. There are several variables in airborne operations that affect support and planning of the mission such as drop zone selection, equipment weight, drop altitude, wind speed, the wind-flight angle, drop height, and jumper density over the drop zone [7]. A study investigating parachuting injuries among Army Rangers found that out of 65 airborne operations conducted, 163 injuries occurred. Fifty-five percent of the operations and jumps were made at night and all operations were performed in a tactical environment with equipment. More injuries occurred during night operations (2.7%) than during the day (1.4%) [8]. Since BA have to remain in peak

physical condition to maintain mission readiness, it is critical to understand injury characterization to aid in injury prevention and treatment.

The Air Force Special Operations Command has expressed the desire to track performance and determine the cost of injuries of these USAF members throughout their career and also identified the need to reduce injuries, increase performance, and reduce hospitalizations in BA. From an epidemiologic perspective, it is imperative to characterize injury phenomena to reduce them, ultimately improving performance.

The aim of this study was to summarize incident injuries by injury type and body region among BA over a 7-year period (2006-2012).

3.0 METHODS

A retrospective cohort study was conducted of 3,413 enlisted, male USAF BA on active duty between calendar years 2006 and 2012, which represents the total identifiable population (N=all). Subjects were selected from Air Force Personnel Center databases based on Air Force Specialty Codes (AFSCs) 1C2X1, 1C4X1, 1T2X1, and 1W0X2, where X=3, 5, 7, or 9. By conditioning on X, this ensured personnel were at the apprentice, journeyman, craftsman, or superintendent skill levels. These AFSCs represent the following career fields: CCT, TACP, PJ, and SOWT. The SOWT AFSC was only available for years 2008-2012.

SF personnel were chosen as a control group, since, like BA, they are a largely male, enlisted population with a high frequency of deployment. Since SF personnel are a generally younger population than BA, control subjects were matched on age as well as gender. From the available pool of 44,265 active duty, male SF with AFSC 3P0X1 (where X=3, 5, 7, or 9) between 2006 and 2012, 3,413 (8%) age- and gender-matched controls were randomly selected. In addition to AFSC, age, and gender, rank was also obtained from the Air Force Personnel Center.

To identify diagnosed musculoskeletal injuries, data were obtained for the 6,826 study subjects from the Military Health System Data Mart (M2). All outpatient and inpatient visits were included in the study, including care that was provided on a military installation (on-base) as well as care that was received off-base. M2 utilizes the International Classification of Diseases, Ninth Revision (ICD-9) coding system. Diagnosis codes of interest for this study were the same as those used by Hauret et al. [9], which included the following range of codes: 716-724, 726-729, and 733, from the broad ICD-9 category of “Diseases of the Musculoskeletal System and Connective Tissue.” Of the 418,086 visits for the study subjects during the course of the study, 36,088 (9%) had a primary diagnosis for a musculoskeletal injury (MSI). Incident cases were defined as having a primary diagnosis for an MSI within the same calendar year. In addition to diagnosis codes and clinic visit dates, cost of appointment was also collected from M2.

Data were also obtained from the Post-Deployment Health Assessment and the Post Deployment Health Reassessment. Specifically, answers to the following questions were obtained: “Were you wounded, injured, assaulted, or otherwise hurt during this deployment?” and “If yes, are you still having problems related to this event?” Medical and health assessment data were combined with demographic data at the individual level.

Secondary data analyses, which were largely descriptive in nature, were performed using SAS version 9.2 (SAS Institute, Inc., Cary, NC.). Univariate analyses were performed using χ^2 . A p-value of less than 0.05 was considered statistically significant.

This study was determined to be non-human use by the Air Force Research Laboratory Institutional Review Board.

4.0 RESULTS

TACP make up the majority of BA (58%); BA are largely airmen (63%) as opposed to non-commissioned officers (NCOs) (see Table 1). BA did not differ from SF with regard to rank ($\chi^2(1)=2.1717$, $p=0.1406$).

Table 1. Demographic Characteristics of USAF Active Duty BA and Selected SF, 2006-2012

Characteristic	CCT n (%)	PJ n (%)	SOWT n (%)	TACP n (%)	BA n (%)	SF n (%)
Age	761 (22.30)	562 (16.47)	105 (3.08)	1,985 (58.16)	3,413	3,413
18-20	127 (16.69)	6 (1.07)	3 (2.86)	463 (23.32)	599 (17.55)	599 (17.55)
21-25	308 (40.47)	250 (44.48)	26 (24.76)	875 (44.08)	1,459 (42.75)	1,459 (42.75)
26-30	155 (20.37)	190 (33.81)	30 (28.57)	318 (16.02)	693 (20.30)	693 (20.30)
31-51	171 (22.47)	116 (20.64)	46 (43.81)	329 (16.57)	662 (19.40)	662 (19.40)
Airmen	472 (62.02)	331 (58.90)	32 (30.48)	1,321 (66.55)	2,156 (63.17)	2,097 (61.44)
NCOs	289 (37.98)	231 (41.10)	73 (69.52)	664 (33.45)	1,257 (36.83)	1,316 (38.56)

Over the course of the study, BA had a total of 5,488 incident injuries as compared to 5,232 for SF. Table 2 displays a summary of incident injuries by body region; the vertebral column and the lower extremities accounted for over 75% of MSIs in both BA and SF. The frequency of incident cases by body region among BA did not differ compared to SF ($\chi^2(3)=6.4145$, $p=0.0931$). SOWT had the highest proportion of injuries per person (1.81) compared to TACP, who had the lowest (1.52). The highest proportion of injuries for each career field was in the vertebral column, except for SOWT, who experienced a higher proportion of lower extremity injuries (see Table 3).

Table 2. Frequency and Proportion of Incident Cases

Body Region	BA		SF	
	n	%	n	%
Vertebral Column	2,156	39.29	2,104	40.21
Upper Extremities	1,169	21.30	1,012	19.34
Lower Extremities	1,973	35.95	1,935	36.98
Unclassified by Site	190	3.46	181	3.46
Total	5,488		5,232	

Table 3. Frequency and Proportion of Incident Cases for BA by Career Field

Body Region	CCT		PJ		SOWT		TACP	
	n	%	n	%	n	%	n	%
Vertebral Column	499	39.32	412	40.91	67	35.26	1,178	38.98
Upper Extremities	277	21.83	233	23.14	33	17.37	626	20.71
Lower Extremities	452	35.62	330	32.77	79	41.58	1,112	36.80
Unclassified by Site	41	3.23	32	3.18	11	5.79	106	3.51
Total	1,269		1,007		190		3,022	
n/Injuries Per Person	761	1.67	562	1.79	105	1.81	1,985	1.52

The three highest frequencies of injury locations were the lumbar vertebral column, comprising 23.94% of all BA injuries and 25.0% of SF injuries; the knee and lower leg, with 20.79% of BA and 22.71% of SF injuries; and the shoulder region, comprising 15.20% of BA and 13.15% of SF injuries (see Table 4). These three injury locations accounted for 59.93% of all BA injuries and 60.86% of all SF injuries. A full matrix of injuries by body region and injury type for BA is available in the Appendix.

Table 4. Frequency and Proportion of Incident Cases by Body Region

Body Region	BA		SF	
	n	%	n	%
Vertebral Column				
Cervical	420	7.65	341	6.52
Lumbar	1,314	23.94	1,308	25.00
Sacrum, coccyx	31	0.56	25	0.48
Spine, back unspecified	318	5.79	327	6.25
Thoracic/dorsal	73	1.33	103	1.97
Total, Vertebral Column	2,156	39.29	2,104	40.21
Upper Extremities				
Forearm, wrist	147	2.68	157	3.00
Hand	76	1.38	78	1.49
Shoulder	834	15.20	688	13.15
Upper arm, elbow	112	2.04	89	1.70
Total, Upper Extremities	1,169	21.30	1,012	19.34
Lower Extremities				
Ankle, foot	629	11.46	595	11.37
Knee, lower leg	1,141	20.79	1,188	22.71
Pelvis, hips, thighs	203	3.70	152	2.91
Total, Lower Extremities	1,973	35.95	1,935	36.98
Unclassified by Site				
Other, unspecified and multiple	25	0.46	25	0.48
Unspecified site	165	3.01	156	2.98
Total, Unclassified by Site	190	3.46	181	3.46
Total	5,488		5,232	

Among BA, results were similar, except PJ had a slightly lower proportion of knee and lower leg injuries but a slightly higher proportion of shoulder injuries. PJ also had a higher proportion of lumbar injuries as compared to the other career fields (see Table 5). SOWT had a lower proportion of shoulder injuries than the other BA career fields, but a higher proportion of ankle and foot injuries.

For total cost per incident injury, injuries to the vertebral column were generally more costly than other body regions. Lumbar injuries were more costly to SF with a median of \$750 per injury compared to \$615 for BA (see Table 6).

In regard to injury during deployment and problems related to that injury upon return to garrison, BA and SF had no significant difference in the relative frequency of personnel who were wounded, injured, assaulted, or otherwise hurt during deployment (see Table 7). Of those who experienced a wound, injury, assault, or were otherwise hurt, BA personnel were significantly less likely to be experiencing problems related to the event within 4 weeks of returning to garrison; 3 to 6 months later, the relative proportions were more similar, but BA were less likely to continue to be experiencing a problem.

Table 5. Frequency and Proportion of Incident Cases for BA by Career Field and Body Region

Body Region	CCT		PJ		SOWT		TACP	
	n	%	n	%	n	%	n	%
Vertebral Column								
Cervical	97	7.60	97	9.60	11	5.80	215	7.10
Lumbar	307	24.20	256	25.40	43	22.60	708	23.40
Sacrum, coccyx	4	0.30	6	0.60	2	1.10	19	0.60
Spine, back unspecified	70	5.50	41	4.10	11	5.80	196	6.50
Thoracic/dorsal	21	1.70	12	1.20	0	0.00	40	1.30
Total, Vertebral Column	499	39.32	412	40.91	67	35.26	1,178	38.98
Upper Extremities								
Forearm, wrist	35	2.80	33	3.30	4	2.10	75	2.50
Hand	13	1.00	11	1.10	5	2.60	47	1.60
Shoulder	200	15.80	172	17.10	19	10.00	443	14.70
Upper arm, elbow	29	2.30	17	1.70	5	2.60	61	2.00
Total, Upper Extremities	277	21.83	233	23.14	33	17.37	626	20.71
Lower Extremities								
Ankle, foot	138	10.90	104	10.30	34	17.90	353	11.70
Knee, lower leg	268	21.10	188	18.70	39	20.50	646	21.40
Pelvis, hips, thighs	46	3.60	38	3.80	6	3.20	113	3.70
Total, Lower Extremities	452	35.62	330	32.77	79	41.58	1,112	36.80
Unclassified by Site								
Other, unspecified and multiple	9	0.70	4	0.40	1	0.50	11	0.40
Unspecified site	32	2.50	28	2.80	10	5.30	95	3.10
Total, Unclassified by Site	41	3.23	32	3.18	11	5.79	106	3.51
Total	1,269		1,007		190		3,022	

Table 6. Medical Cost in U.S. Dollars Per Incident Injury

Body Region	BA				SF			
	Median	Mean	SD ^a	Max	Median	Mean	SD ^a	Max
Vertebral Column	615	3,238	12,131	214,622	750	3,883	13,751	261,592
Upper Extremities	513	3,242	12,113	251,659	646	3,004	8,029	86,547
Lower Extremities	475	2,010	7,632	179,011	601	2,677	16,702	639,197
Unclassified by Site	601	2,101	4,967	46,045	568	4,170	25,629	336,912
Total	542	2,760	10,543	251,659	663	3,297	14,749	639,197

Table 7. Injuries Related to Deployment

Question	BA		SF		χ^2
	n	%	n	%	p-value
Asked within 4 weeks of return from deployment:					
Were you wounded, injured, assaulted, or otherwise hurt during this deployment?					0.401
Yes	394	12.99	230	12.18	
No	2,638	87.01	1,659	87.82	
If yes, are you still having problems related to this event?					0.007
Yes	241	31.32	114	50.22	
No	152	38.68	113	49.78	
Asked within 3 to 6 months of return from deployment:					
If yes, are you still having problems related to this event?					0.048
Yes	150	54.95	117	64.29	
No	83	30.40	43	23.63	

5.0 CONCLUSION

The data show that BA and SF have similar injury rates, with injuries to the lumbar vertebral column being most common and most expensive. The main limitation of this study is that the true burden of disease is likely underrepresented by these data. Use of medical records to quantify the injuries requires that the patient be seen in a medical clinic and diagnosed with an injury. There are likely many injuries among BA and SF that are not severe enough to warrant a medical visit. The authors expected BA to have a higher rate of injury. The results shown here may indicate that BA are simply less likely to visit the clinic for their injuries.

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APPENDIX

Injury Matrix for BA

Body Region	Inflammation and Pain (overuse)	Joint Derangement	Joint Derangement with Neurological Involvement	Stress Fracture	Sprain/ Strain/ Rupture	Dislocation	Total	Total %
Vertebral Column								
<i>Cervical</i>	340	35	45	0	0	0	420	7.65
<i>Thoracic/dorsal</i>	0	1	72	0	0	0	73	1.33
<i>Lumbar</i>	1,177	89	48	0	0	0	1,314	23.94
<i>Sacrum, coccyx</i>	31	0	0	0	0	0	31	0.56
<i>Spine, back unspecified</i>	294	20	4	0	0	0	318	5.79
Upper Extremities								
<i>Shoulder</i>	766	43	0	0	14	11	834	15.20
<i>Upper arm, elbow</i>	111	1	0	0	0	0	112	2.04
<i>Forearm, wrist</i>	143	4	0	0	0	0	14	2.68
<i>Hand</i>	66	2	0	0	8	0	76	1.38
Lower Extremities								
<i>Pelvis, hip, thigh</i>	199	2	0	2	0	0	203	3.70
<i>Knee, lower leg</i>	1,019	92	0	24	6	0	1,141	20.79
<i>Ankle, foot</i>	571	34	0	15	6	3	629	11.46
Unclassified by Site								
<i>Other specified and multiple</i>	23	0	0	1	1	0	25	0.46
<i>Unspecified site</i>	121	3	24	15	2	0	165	3.01
Total	4,861	326	193	57	37	14	5,488	100.00
Total %	88.58	5.94	3.52	1.04	0.67	0.26	100.00	

LIST OF ABBREVIATIONS AND ACRONYMS

AFSC	Air Force Specialty Code
BA	Battlefield Airmen
CCT	Combat Controller
ICD-9	International Classification of Diseases, Ninth Revision
M2	Military Health System Data Mart
MSI	musculoskeletal injury
NCO	non-commissioned officer
PJ	Pararescuemen
SF	Special Forces
SOWT	Special Operations Weather Technician
TACP	Tactical Air Control Party
USAF	U.S. Air Force